

**WATER BIRD ABUNDANCE AND DISTRIBUTION  
ON INNOKO NATIONAL WILDLIFE REFUGE, ALASKA**

by

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Data and conclusions presented here are preliminary and are not for publication or citation without permission from the author.

## **EXECUTIVE SUMMARY**

Surveys were flown to estimate abundance and map distribution of water birds in early June 1994 and 1995 on Innoko National Wildlife Refuge (INWR), Alaska and adjacent wetlands along the Yukon River. The survey was flown over the southern unit of INWR in 1994 and over the northern unit and along the Yukon River in 1995. An estimated 80,000 ducks, 6,600 geese, and 200 loons were present on INWR in June 1994. Northern pintails were the most numerous ducks comprising 28% of the duck population. Other abundant species included green-winged teal, American wigeon and scaup. Coefficients of variation for population indices of abundant species ranged from 17-25%. Estimates for the 1995 survey were 132,000 ducks, 1,100 geese, and 1,000 loons. Green-winged teal were most abundant with 26% of the duck population followed by wigeon, mallard and pintail in decreasing order of abundance.

A computerized geographic information system (GIS) was used to map densities for abundant species. In 1994 distribution of most species was highly patchy except for pintails, scaup and Canada geese which tended to have more contiguous distributions. Higher densities of most species occurred predominantly along the lower Iditarod and Innoko rivers in the southern portion of the survey area. In 1995 the survey area along the Yukon River from Kaltag to Grayling had low numbers of ducks, whereas the Kaiyuh Flats and the Paimiut Slough areas contained higher numbers.

The aerial survey systematic design and GIS analyses provide detailed water bird abundance and distribution information. Results can be compared to those from the North American Waterfowl Breeding Population Survey on INWR to evaluate both designs and improve subsequent surveys to meet specific objectives. Region 7, Division of Realty has used the water bird density maps in their Acquisition Priority System model. Maps can be used as data layers for further analyses such as creating stratified survey designs and examining relationships between remotely sensed habitat data and water bird distribution.

## **INTRODUCTION**

An aerial waterfowl breeding population survey was initiated in 1957 and has been conducted annually on the INWR as part of the North American Waterfowl Breeding Population Survey (NAWBPS) (Conant and Groves 1992). The purpose of the NAWBPS is to provide population indices for use in developing waterfowl harvest regulations. Intensity of coverage on INWR by this survey is limited since it is only one of 12 strata surveyed annually by one crew in Alaska and the Yukon Territory. On INWR, the survey consists of seven transects totaling 285 km. Transect placement was based on landmarks as aids in navigation to ease annual repeatability of the survey. Consequently, important habitats may not have been adequately sampled or conversely, could have been oversampled. Thus, non-random placement of transects may result in biased estimates of bird abundance. Also, because NAWBPS data are recorded by 16-mile segments along each transect, these data provide limited information on water bird distribution.

Within the last 10 years, several improvements and advancements in technology have been incorporated into designing and conducting aerial surveys and analyzing data in Alaska by Migratory Bird Management, Anchorage. We began by using a statistically valid standard survey design with systematically spaced transects following suggestions of Caughley (1977). We developed a geographic information system consisting of custom True BASIC programs and PC ARC/INFO software which allow us to generate a set of transects for any geographic area and plot them on topographic maps for use in the aircraft. Use of a Global Positioning System (GPS), enabled us to accurately navigate systematic transects. We also used a technique to obtain geographic coordinates of every bird observation using continuously

running cassette recorders and a computerized data entry program which was developed by Butler et al. (1995a). Bird location data are then entered into the GIS allowing mapping of species density (Butler et al. 1995b) as well as further analyses such as developing stratifications for population estimates or overlays with habitat information.

This system has been used on the Bristol Bay region (Platte and Butler 1995), Yukon Flats National Wildlife Refuge (Platte and Butler 1992), Yukon Delta National Wildlife Refuge (Balogh and Butler 1994, Platte and Butler 1993), Copper River Delta (Butler and Eldridge 1991), the west coast of Alaska, and the arctic coastal plain of Alaska (Brackney and King 1993, Larned and Balogh 1993). Improvements include increased precision in population indices, greater resolution in density distribution maps, and calculation of population indices on federal versus non-federal land.

The objectives for the expanded aerial breeding population survey on INWR were as follows:

1. Estimate the abundance of water birds.
2. Delineate the density distribution of water birds.
3. Compare the new survey design with the historic design.

Comparison of the expanded breeding population survey results with those of the NAWBPS and development of an improved survey design will be addressed in a future report.

## **STUDY AREA**

Innoko National Wildlife Refuge is bordered on the west by the Yukon River and on the south and east by the Kuskokwim Mountains in west central Alaska (Fig. 1). In 1994, the survey area extended 190 km north to south and 160 km east to west encompassing 7,343 km<sup>2</sup> of the Innoko lowlands area on the refuge (Fig. 2). The 1995 survey area encompassed the Kaiyuh Flats (northern unit of INWR), which is 80% water or wetlands, and the floodplain south along the Yukon River to the eastern border of Yukon Delta National Wildlife Refuge.

This area is a level plain along the Innoko River with extensive wetlands consisting of many small lakes, streams and bogs. The Yetna, Iditarod, and Dishna are the other major rivers in the area and tend to be slow, silty, and meandering. Nutrient input to wetlands appears to depend on the yearly flooding and drawdown regime of these rivers. There are over 25,000 lakes less than .4 km<sup>2</sup> in size and over 300 lakes greater than .4 km<sup>2</sup> on the refuge (U.S. Fish and Wildlife Service 1987). The types of lakes present are oxbow, river flooded lowland, ice formed lowland and upland basin (U.S. Fish and Wildlife Service 1987).

The survey area contains vegetation typical of the transition zone between the boreal forest of interior Alaska and the shrub land and tundra type common in western and northern Alaska (U.S. Fish and Wildlife Service 1987). The main forces influencing vegetation are fire and extensive flooding. White spruce is common along rivers where the soils are better drained whereas black spruce bogs develop on more poorly drained soils. Vast areas of willow, alder and birch have been created as a result of numerous fires. Rivers and sloughs commonly have dense stands of alder and willow along their banks. However, regular flooding of the lower Innoko and Iditarod area inhibits succession of woody shrubs and promotes

growth of grasses and sedges. The dominant characteristic of the vegetation is the complex mosaic of types present on the area.

The climate of the area is continental subarctic characterized by large seasonal extremes in both temperature and daylight. Rivers, lakes and sloughs typically freeze in late October to early November and thaw in early to mid-May. Average annual precipitation is 18 inches.

## **METHODS**

### Aerial Survey Technique

The traditional NAWBPS transects are shown in Figure 1. For the expanded breeding population survey, we used a True Basic program and PC ARC/INFO to generate systematically spaced transects from a random coordinate within the predetermined survey area. The 1994 survey area included all wetland habitats on the southern unit of the refuge except the area immediately east of and along the Yukon River. This area was not surveyed due to limited time because of the high survey intensity needed to adequately map distributions on the main wetlands of the refuge. Transects were oriented east-west along great circle routes and totaled 1,975 kms (Fig. 2) in 1994 and 1,250 kms (Fig. 3) in 1995. Systematic sampling was appropriate for the dual objectives of mapping distributions and estimating total numbers when accuracy of the estimate's standard error was not critical (Caughley 1977). We divided transects into 14.8 km segments to facilitate data recording and plotted transects and segments on 1:250,000 scale topographic maps for use in the aircraft. Distance between transects in 1994 was 3.7 km resulting in a sample of 395 km<sup>2</sup> (5%) of the 7,343 km<sup>2</sup> survey area. In 1995, transects were spaced every 7.4 km for a sample of 500 km<sup>2</sup> (6%) of the 9,179 km<sup>2</sup> survey area.

Survey methods followed the conventions established for breeding ground surveys in North America (USFWS and CWS 1987). The survey was flown from 1 - 5 June 1994 and 30 May to 1 June 1995 to coincided with egg-laying or early incubation stages of breeding waterfowl. The aircraft was flown at 137 - 153 km hr<sup>-1</sup>, 30 - 46 m of altitude, with wind speed < 24 km hr<sup>-1</sup>, ceilings > 152 m and visibility > 16 km. The pilot used a global positioning system and the survey maps to maintain a precise course while flying transects.

The pilot and observer recorded transect numbers, segment numbers, segment start and stop points, direction of flight and bird observations on continuously running cassette tapes. Birds observed were identified to species and counted as a single, pair, or number in flock.

Geographic coordinates of each observed bird were captured using a technique developed by Butler et al. (1995a). Tapes were replayed and data were entered simultaneous with the recording into a computer in real time using a True BASIC program. Distances along segments to observations were calculated based on elapsed time to an observation in proportion to elapsed time to fly the segment of known length. These observation distances were then converted to geographic coordinates using another True BASIC program.

### Population indices

We calculated densities, population indices and variability for each species using a ratio estimate described by Cochran (1977). Indices were based on indicated total birds:  $2*(S+P)+F$  where S = number

of single birds observed, P = number of bird pairs observed, and F = number of birds in flocks. For ducks, a single male was assumed to represent a breeding pair with the nesting hen not easily observable. Single male ducks were doubled for all observed species except scaup. Single observations of other water bird species (geese, swans, cranes, grebes and loons) were not doubled. Numbers of ducks were corrected for visibility bias using correction factors from Conant and Groves (1992) (Table 1). Numbers for other water bird species were not corrected for visibility bias.

Population index variance was based on the variation among sampling units (entire transects). The sample size (number of transects) was 118 in 1994 and 48 in 1995. Segments were not used in calculation of variance nor was any stratification employed in the analyses. The additional variance associated with visibility correction factors was not included in our calculations.

### Water bird distribution

We produced water bird density distribution maps using a technique developed by Butler et al. (1995b). Geographic coordinates of observed birds were calculated in True BASIC by combining transect position and length files with bird observation files. Another True BASIC program used a moving average technique (Eberhardt and Thomas 1991) to calculate bird density in blocks of specified area at specified regular intervals along each transect. In this case, an average density was calculated every 2 km for blocks of 6 km along each flight line. The resulting location and density data were input into PC TIN, a 3-dimensional terrain modeling software package to produce choropleth (patterned polygons) maps of water bird density for abundant species. Density values were based on indicated total birds uncorrected for visibility bias because geographic distribution of the bias is unknown.

## **RESULTS AND DISCUSSION**

### Population indices

We estimated  $79,866 \pm 26,688$  ducks, and  $6,609 \pm 3,316$  geese (mean  $\pm$  95% CI) on the INWR area in 1994 (Table 2). Mean density was about  $3/\text{km}^2$  for pintails, slightly over  $2/\text{km}^2$  for green-winged teal, and  $11/\text{km}^2$  for all ducks. Pintails were the most abundant ducks with over 22,000 birds. They accounted for about 28% of the estimated duck population. Proportion of the population for other species was: 21% green-winged teal, 17% American wigeon, 12% scaup, 10% northern shoveler, 4% mallard, 3% goldeneye, 3% black scoter, 1% surf scoter, and 1% bufflehead. The goose population was comprised of 61% Canada geese and 39% white-fronted geese. Coefficients of variation for the dabbling duck species, except for gadwalls, and scaup ranged from 17 - 27%. Variability was relatively high for other species.

In 1995 there were  $132,070 \pm 24,583$  ducks and  $1,102 \pm 709$  geese on the surveyed area. Green-winged teal were most abundant followed by wigeon, mallard, and pintail. Scaup were the most abundant diver. Species composition was 26% green-winged teal, 22% wigeon, 12% mallard, 11% pintail, 10% shoveler, 8% scaup, 5% goldeneye, and 2% bufflehead.

Lensink and Rothe (1986) reported that duck densities obtained by aerial survey were lower on the INWR than on Yukon Flats National Wildlife Refuge perhaps because of the predominance of unproductive closed basin lakes over most of the region. Total duck density on INWR during June 1994 was about  $11/\text{km}^2$  whereas average density on the Yukon Flats from 1989-1991 was about  $24/\text{km}^2$  (Table

4). Duck densities on the Innoko area were lower than densities on the Yukon Delta but higher than those on the arctic coastal plain of Alaska.

#### Water bird distribution

More than 1,500 geographic locations of birds were obtained from the 1994 survey. Water bird distribution was mapped for the major species occurring on the survey areas. Distribution of most species was highly patchy except for pintails, scaup and Canada geese which tended to have more contiguous distributions. Highest densities for most species occurred along the lower Yetna, Iditarod and Innoko rivers. This area contained many drained lakes whose water levels fluctuate with those of the Iditarod and Innoko rivers creating an abundance of important habitat (Lensink and Rothe 1986). Other concentrations of ducks, particularly mallards, pintails, widgeon, scaup and goldeneyes, occurred farther north along the Innoko River in the upper third of the survey area. Several areas had few or no water birds including much of the northwest corner of the survey area west of the Innoko River and the southernmost portion west of the Iditarod River. Generally, densities decreased away from the river corridors, up the smaller drainages, and as elevation increased toward the survey area periphery. Future surveys might be more efficient if these parts of the survey area were eliminated or sampled less intensively.

Over 1,300 locations were recorded for the 1995 survey. The Kaiyuh Flats were particularly important for widgeon and scaup. The western part of the southern unit of the refuge along the Yukon River had relatively few ducks, and most of these were dabblers. The wetlands south of the refuge and east of the Yukon River had substantial concentrations of dabblers and scaup.

### **RECOMMENDATIONS**

Accurate water bird abundance and distribution information over large geographic areas provides baseline information for management decision-making. The information can be used for land acquisition planning, mitigation planning, permit reviews, harvest regulation, and identification of unique ecological areas. Waterfowl density maps for the Yukon Delta and Yukon Flats National Wildlife refuges have been incorporated into the Division of Realty Acquisition Priority System model for ranking private lands within refuges for acquisition. Maps for INWR will also be included in this model.

Analyses should be conducted to compare the results from this survey and the NAWBPS. This information is important for designing future surveys to meet specific objectives.

Water bird distribution and abundance have been mapped on many of the important wetlands in Alaska using the survey techniques and geographic information system developed by Migratory Bird Management. However, important areas remain that have not been intensively surveyed. These areas could potentially be sampled in one year (given adequate time, money, personnel and aircraft availability) at sufficient intensity for detailed distribution mapping. We recommend that expanded surveys be conducted in these areas to contribute to a standardized water bird database for the State of Alaska.

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**Table 1. Visibility correction factors used to correct population indices from fixed-wing aerial surveys on Innoko National Wildlife Refuge and adjacent wetlands along the Yukon River, Alaska, 1994 and 1995.**

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<b>Mallard</b>	<b>3.57</b>
<b>Gadwall</b>	<b>3.04</b>
<b>Northern pintail</b>	<b>2.51</b>
<b>Green-winged teal</b>	<b>8.88</b>
<b>American wigeon</b>	<b>3.65</b>
<b>Northern shoveler</b>	<b>3.35</b>
<b>Scaup</b>	<b>1.82</b>
<b>Goldeneye</b>	<b>3.61</b>
<b>Bufflehead</b>	<b>1.86</b>
<b>Surf scoter</b>	<b>1.08</b>
<b>Black scoter</b>	<b>1.08</b>
<b>Red-breasted merganser</b>	<b>1.27</b>
<b>Geese</b>	<b>1.00</b>
<b>Swans</b>	<b>1.00</b>
<b>Cranes</b>	<b>1.00</b>
<b>Grebes</b>	<b>1.00</b>
<b>Loons</b>	<b>1.00</b>

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**Table 2. Water bird densities (per km<sup>2</sup>), population indices and variability from aerial survey in June 1994 of the southern unit of Innoko National Wildlife Refuge, Alaska.**

Species	Density	Population Index*			%CV <sup>1</sup>	lo95CI <sup>2</sup>	up95CI <sup>3</sup>	%CI <sup>4</sup>
	mean	se	total	se				
Mallard	0.49	0.12	3,589	894	25	1,837	5,340	49
Gadwall	0.02	0.02	113	114	101	2	337	197
Northern pintail	3.06	0.75	22,476	5,507	25	11,683	33,270	48
Green-winged teal	2.25	0.49	16,532	3,573	22	9,528	23,536	42
American wigeon	1.80	0.31	13,182	2,270	17	8,734	17,631	34
Northern shoveler	1.07	0.29	7,858	2,111	27	3,720	11,996	53
Dabbler Subtotal	8.68	1.62	63,750	11,877	19	40,471	87,030	37
Scaup**	1.26	0.25	9,284	1,861	20	5,637	12,930	39
Goldeneye	0.33	0.14	2,419	1,036	43	388	4,451	84
Bufflehead	0.11	0.04	831	263	32	316	1,346	62
Black scoter	0.31	0.10	2,252	754	33	775	3,729	66
Surf scoter	0.14	0.06	1,046	401	38	259	1,832	75
Red-breasted merganser	0.04	0.02	284	108	38	72	495	75
Sea Duck Subtotal	0.93	0.19	6,832	1,427	21	4,035	9,629	41
Canada goose**	0.55	0.20	4,021	1,447	36	1,186	6,856	71
White-fronted goose**	0.35	0.11	2,588	833	32	955	4,220	63
TOTAL GEESE	0.09	0.23	6,609	1,692	26	3,293	9,925	50
Trumpeter swan**	0.03	0.01	205	82	40	43	366	79
Sandhill crane**	0.02	0.01	168	103	61	9	369	120
Red-necked grebe**	0.05	0.02	372	134	36	109	636	71
Common loon**	0.01	0.01	56	40	72	3	134	141
Pacific loon**	0.01	0.01	93	47	50	5	185	99
Red-throated loon**	0.01	0.01	74	73	99	4	219	193
TOTAL LOONS	0.03	0.01	223	90	40	48	399	79

\* Population index = A \* T/S \* V

A = Square kilometers in survey area = 7,343 T = indicated total birds: 2 \* (singles + pairs) + flocks

S = Square kilometers in sample = 395 V = visibility ratio

Sample size n (number of transects) = 118

\*\* Single birds not doubled to calculate indicated total birds

1 Percent coefficient of variation

2 Lower 95% confidence limit

3 Upper 95% confidence limit

4 Percent confidence interval

**Table 3. Water bird densities (per km<sup>2</sup>), population indices and variability from aerial survey in June 1995 of the northern unit of Innoko National Wildlife Refuge and wetlands adjacent to the Yukon River, Alaska.**

Species	Density	Population Index*			%CV <sup>1</sup>	lo95CI <sup>2</sup>	up95CI <sup>3</sup>	%CI <sup>4</sup>
	mean	se	total	se				
Mallard	1.74	0.28	16,000	2,607	16	10,890	21,111	32
Gadwall	0.01	0.01	112	112	100	2	332	197
Northern pintail	1.65	0.26	15,168	2,416	16	10,433	19,904	31
Green-winged teal	3.73	0.47	34,253	4,288	13	25,848	42,658	25
American wigeon	3.21	0.40	29,432	3,688	13	22,205	36,660	25
Northern shoveler	1.53	0.19	14,030	1,758	13	10,583	17,476	25
Dabbler Subtotal	11.88	1.00	108,995	9,148	8	91,064	126,925	16
Scaup**	1.21	0.20	11,099	1,815	16	7,542	14,655	32
Canvasback	0.11	0.05	982	484	49	33	1,931	97
Ring-necked duck**	0.01	0.01	92	51	56	5	192	109
Diver Subtotal	1.36	0.21	12,450	1,931	16	8,665	16,235	30
Goldeneye	0.72	0.14	6,631	1,321	20	4,041	9,221	39
Bufflehead	0.28	0.06	2,528	531	21	1,487	3,569	41
Oldsquaw	0.01	0.01	73	74	102	2	219	199
Black scoter	0.02	0.01	159	73	46	15	303	91
White-winged scoter	0.04	0.03	357	248	69	13	842	136
Surf scoter	0.04	0.02	317	177	56	15	664	109
Red-breasted merganser	0.02	0.01	187	113	61	5	409	119
Common merganser	0.04	0.04	373	373	100	14	1,103	196
Sea Duck Subtotal	1.16	0.16	10,625	1,463	14	7,758	13,493	27
Canada goose**	0.04	0.02	404	141	35	128	680	68
White-fronted goose**	0.08	0.04	698	337	48	38	1,358	95
TOTAL GEESE	0.12	0.04	1,102	362	33	393	1,811	64
Trumpeter swan**	0.07	0.02	680	171	25	344	1,016	49
Sandhill crane**	0.01	0.01	92	47	51	5	183	100
Red-necked grebe**	0.14	0.03	1,286	259	20	778	1,793	39
Common loon**	0.04	0.01	331	107	32	121	540	63
Pacific loon**	0.06	0.02	588	180	31	234	942	60
Red-throated loon**	0.01	0.01	92	46	50	1	182	99
TOTAL LOONS	0.11	0.02	1,010	196	19	626	1,349	38

\* Population index = A \* T/S \* V

A = Square kilometers in survey area = 9,179 T = indicated total birds: 2 \* (singles + pairs) + flocks

S = Square kilometers in sample = 500 V = visibility ratio

Sample size n (number of transects) = 48

\*\* Single birds not doubled to calculate indicated total birds

1 Percent coefficient of variation

2 Lower 95% confidence limit

3 Upper 95% confidence limit

4 Percent confidence interval

**Table 4. Comparison of densities<sup>1</sup> (per km<sup>2</sup>) for selected species and total ducks from spring aerial surveys on 5 survey areas in Alaska.**

Species or group	Survey area					
	Yukon Delta NWR <sup>2</sup>	Yukon Flats NWR <sup>3</sup>	southern unit Arctic coastal plain <sup>4</sup>	northern unit Bristol Bay region <sup>5</sup>	Innoko NWR <sup>6</sup>	Innoko NWR <sup>6</sup> and Yukon River wetlands <sup>7</sup>
Northern pintail	4.7	3.0	3.4	1.1	3.1	1.7
Mallard	1.0	3.4	0.5	0.9	0.5	1.7
Green-winged teal	1.9	1.8	0.1	1.0	2.3	3.7
American widgeon	1.1	3.1	0.1	0.4	1.8	3.2
Northern shoveler	1.3	2.5	--	0.3	1.1	1.5
Canvasback	0.1	1.5	--	--	--	0.1
Scaup	2.8	6.1	0.4	1.9	1.3	1.2
Oldsquaw	0.5	0.1	1.5	0.1	--	--
Scoter	1.2	1.9	0.2	1.0	0.5	0.1
<b>Total ducks</b>	<b>16.0</b>	<b>24.0</b>	<b>6.0</b>	<b>7.0</b>	<b>11.0</b>	<b>13.2</b>

**1** Densities are based on indicated total birds corrected for visibility bias and calculated as average of mean annual densities.

**2** Surveys from 1989-1992

**3** Surveys from 1989-1991

**4** Surveys from 1986-1990

**5** Surveys from 1993-1994

**6** Survey in 1994

**7** Survey in 1995

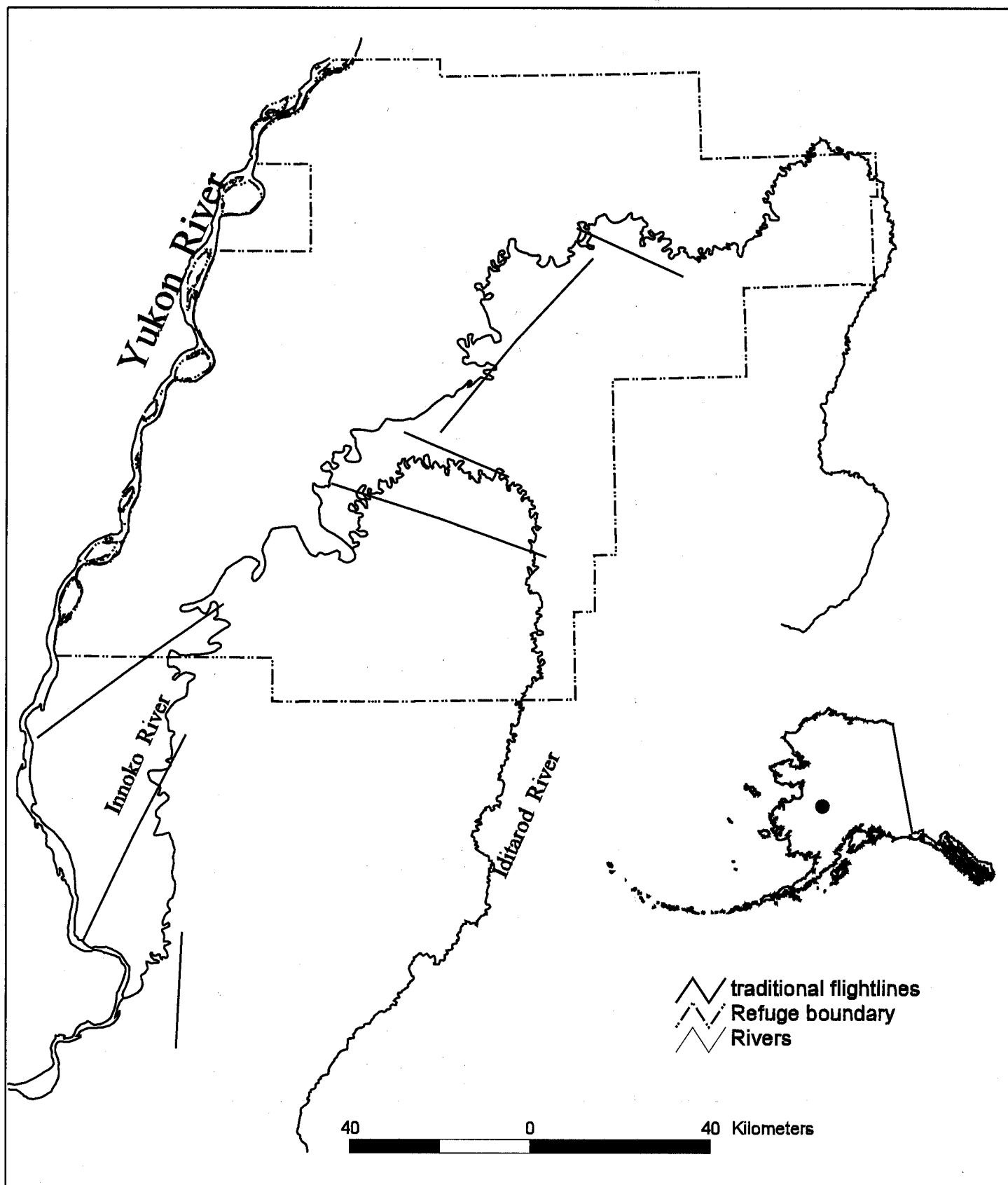


Figure 1. Location of traditional breeding pair aerial survey flightlines in the Innoko National Wildlife Refuge area, Alaska.

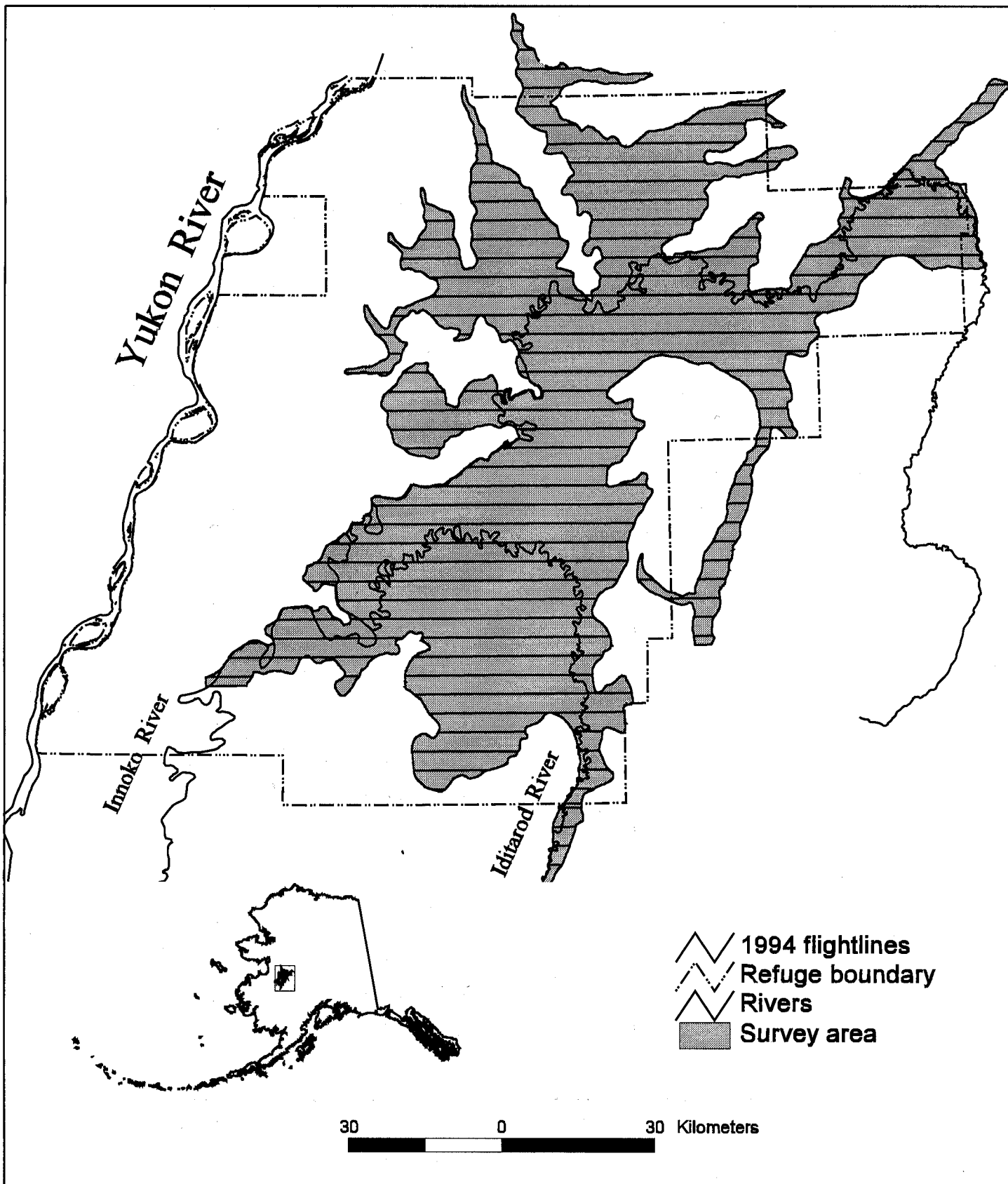


Figure 2. Location of water bird aerial survey flightlines flown in June 1994 within the survey area on Innoko National Wildlife Refuge , Alaska.

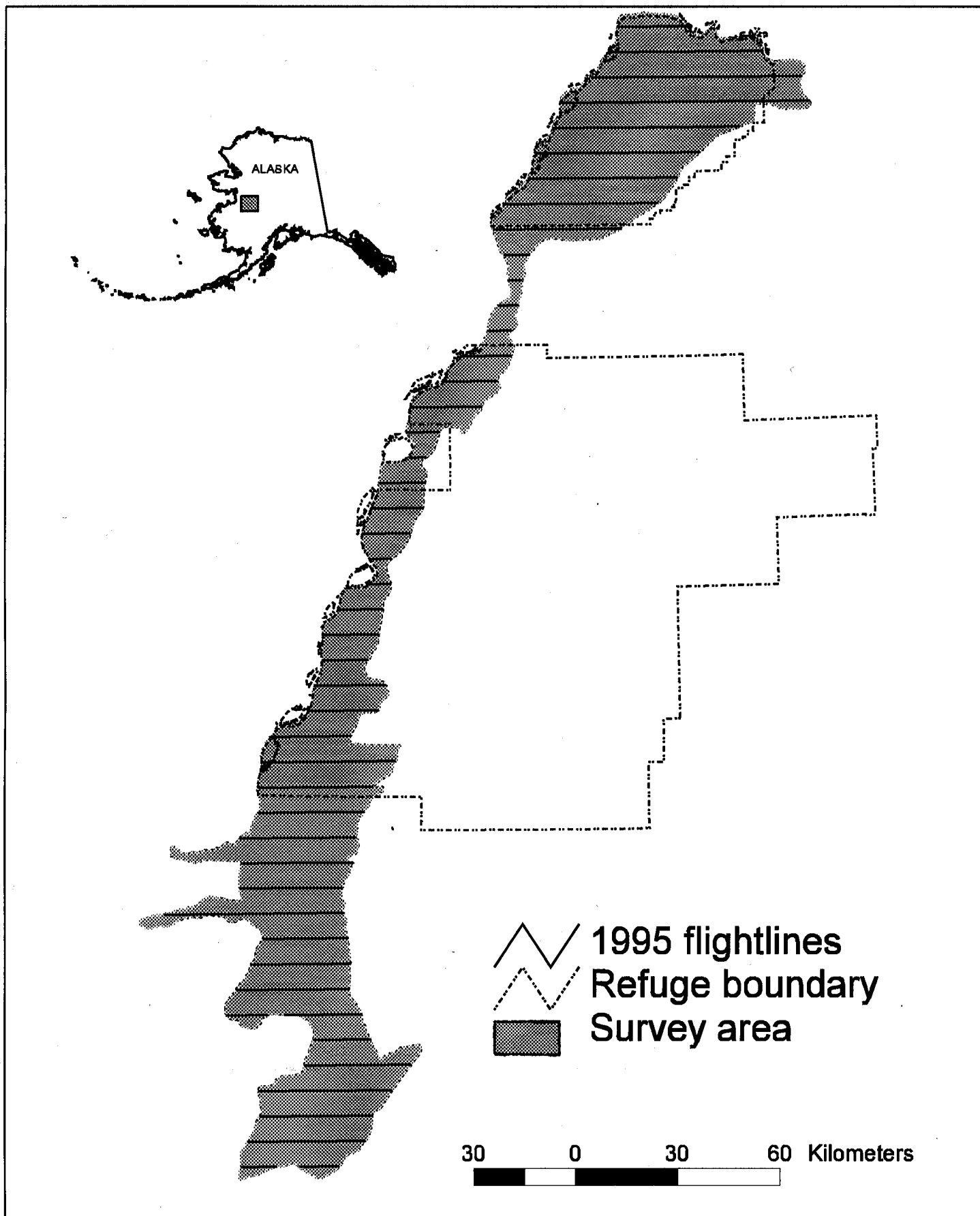
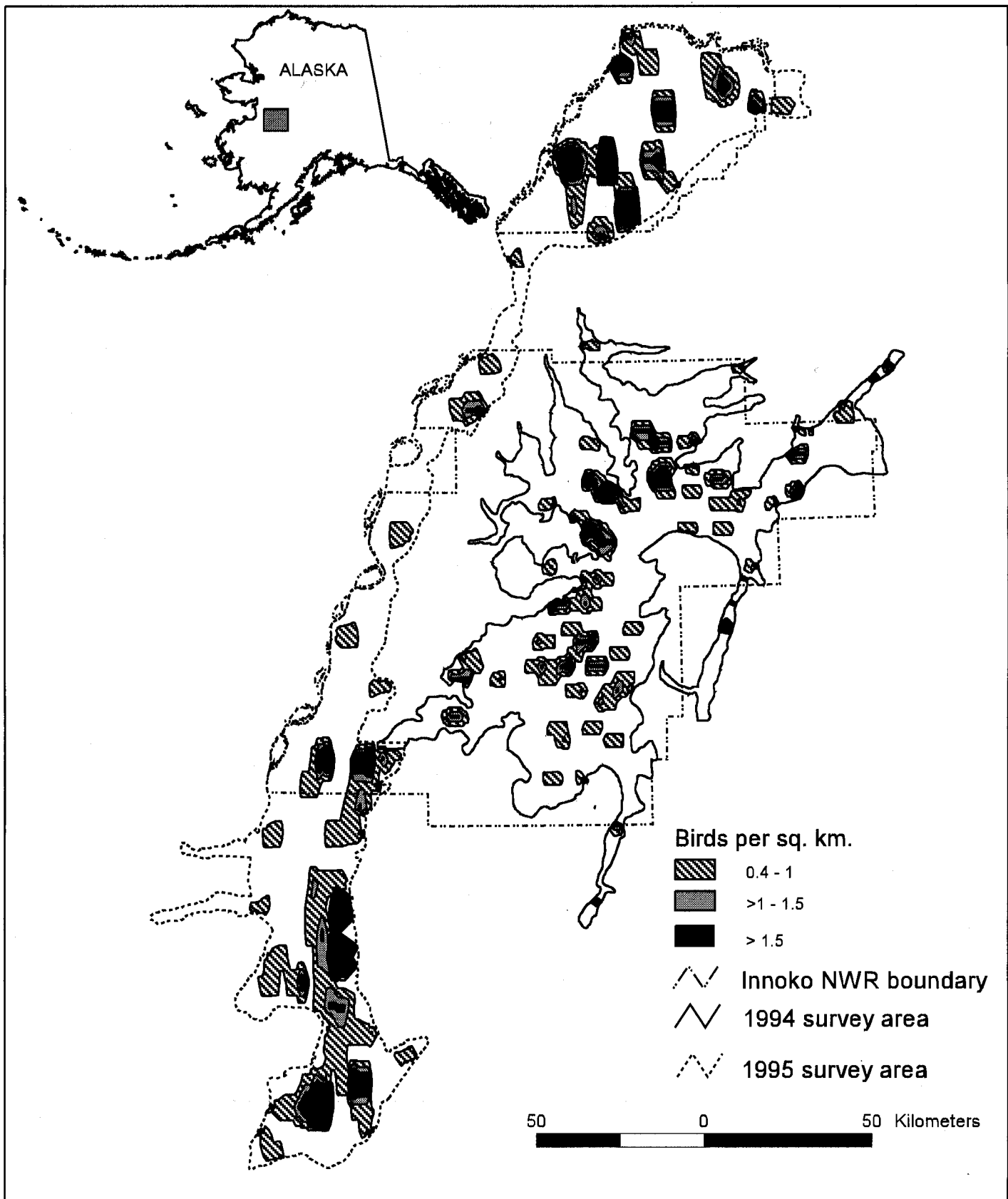


Figure 3. Location of water bird aerial survey flightlines flown in June 1995 on the upper unit of Innoko and Yukon River wetlands, Alaska.

## DISTRIBUTION FIGURES



Relative density distribution of mallards from June 1994 and 1995 aerial surveys on Innoko National Wildlife Refuge , Alaska.